Cruise control with interval sensing for a motor vehicle

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Inventor(s):	STEINLE JOACHIM DR [DE]; TSCHERNOSTER OLIVER [DE]; PFEIFFER ANDREAS DR [DE] +
Applicant(s):	BAYERISCHE MOTOREN WERKE AG [DE] +
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Abstract of EP 1304251 (A1)

The system has a distance sensing arrangement and automatically ensures a minimum vehicle separation at high speeds and in stop and go traffic situations. It presents a uniform system structure to the driver and is not noticeably divided into different speed ranges, although it responds differently in stop and go situations than in high speed situations

[0001] The present invention relates to a speed control system having a distance sensor system for a motor vehicle, this system automatically ensuring the maintenance of a minimum distance with respect to a preceding vehicle, which has been detected by the system as a target object, not only at higher driving speeds, but in particular also in stop-and-go operation. Regarding the related art, reference is made to DE 199 58 520 A1.

[0002] Motor vehicles, in particular passenger cars, having a speed control system including a distance sensor system may today already be purchased from some manufacturers. Such a system, offered for example by the applicant of the present patent application under the name "active cruise control", makes it possible to move the motor vehicle automatically at a desired or an accordingly lower speed while maintaining a desired distance with respect to a motor vehicle driving in front of it (this is called the target object). For this purpose, in principle, the generally known driving speed control system, which maintains a certain specified speed, is expanded by an additional distance function such that the use of such an "active" driving speed control system becomes possible even in dense expressway and highway traffic. This so-called "active driving speed control system" maintains the specified desired speed like the conventional speed controller when the host vehicle's own driving lane is free. If a distance sensor system attached to the motor vehicle, which is able to operate in particular on the basis of radar, detects a preceding target object or (motor) vehicle in the host vehicle's own lane, then the host vehicle's own speed is adapted to that of the preceding motor vehicle/target object in such a way that a distance control included in the "active driving speed control" or in the

corresponding speed control system automatically maintains a distance with respect to the preceding motor vehicle/target object that is appropriate to the situation and accordingly decreases its "own" driving speed, i.e. that of the vehicle equipped with the so-called active driving speed control system.

[0003] The system offered by the applicant of the present patent application under the name of "active cruise control" for example is usable only in a speed range of 30 to 180 km/h, while in the speed range below 30 km/h this system is not activatable or automatically switches itself off according to a certain algorithm. Also, stationary target objects - with respect to which fundamentally a distance must be maintained as well - cannot be used or can be used only to a limited extent for control purposes.

[0004] In order to be able to use a speed control system having a distance sensor system even in the speed range below e.g. 30 km/h, in particular in traffic-jam situations, a sensor viewing zone expanded by additional sensors is required. Furthermore, an algorithm should be able to differentiate between relevant stationary and traveling target objects. One possible system development could be to differentiate between a conventional control range, in which no reaction occurs in response to stationary targets, and a stop-and-go range, in which a reaction occurs in response to stationary target objects. In terms of speed, this so-called stop-and-go range may be limited upwards by a limit value e.g. in the order of magnitude of 30 km/h.

[0005] The document DE 199 58 520 A1 mentioned at the outset describes a speed control system having a distance sensor system according to the preamble of Claim 1, which performs such a

differentiation between the usual operation at higher driving speeds and a special stop-and-go operation for relatively low travel speeds as well as the standstill of the vehicle, and which either reacts or does not react to stationary target objects as a function of the respective operating state. However, this differentiation between a hitherto customary control range at higher driving speeds and a so-called stop-and-go range (and thus also between a reaction and no reaction to stationary target objects) must communicated to the driver of the motor vehicle in a suitable manner. The driver must possibly even switch by an operating action between the two mentioned control ranges.

[0006] An expansion, developed in this way, of a hitherto customary speed control system (operating only at higher driving speeds) into the lower speed range (the so-called stop-and-go operation), particularly involving a switchover to be performed by the driver, however, quickly results in a manifold variety of necessary operating actions that is confusing for the driver. Because of this manifold variety, a driver is possibly also in danger of confusing the ranges in which there is a reaction and in which there is no reaction to stationary target objects. When taking stationary target objects into account, there is the additional danger that, for example, due to the selection of a non-relevant target object (e.g. a vehicle parked at the shoulder of the road, guardrails, etc.) a vehicle reaction is caused that is implausible both for the driver of the motor vehicle and for the following traffic, e.g. in the form of an unexpectedly severe deceleration of the vehicle motion.

[0007] The objective of the present invention is to indicate a remedy measure for the problem described.

In a speed control system according to the preamble of Claim 1, the achievement of this objective is characterized in that the driver of the motor vehicle is presented with a unified system structure which is in particular not obviously divided into different speed ranges, even though the speed control system in the stop-and-go operation reacts differently at least in response to one of the conditions indicated in Claims 2 or 4 or 6 than at higher driving speeds, that is, in a manner indicated in one of Claims 2 or 4 or 6. Advantageous refinements are contained in the respective dependent claims.

[0008] Generally, to remedy the above-mentioned disadvantages, a speed control system having a distance sensor system is thus provided which operates practically in the entire operating range of the motor vehicle and in particular also in the stop-and-go operation, and which in so doing performs no differentiation obvious to the driver. The driver thus has to operate only one single system with essentially unified and in particular sensible, clearly understandable behavior patterns. On the other hand, within the system, different ranges are to be distinguished, i.e. in order to increase the system safety and to avoid erroneous reactions on the part of the driver, different system reactions to specific conditions are quite desired, depending on whether the motor vehicle is currently driven at a higher speed or whether it is in stop-and-go operation. To begin, it should be mentioned at this point by way of example that in the stop-and-go operation the system should not completely ignore a stationary target object, but in so doing it must not react as in the case of an initially moving and then decelerating target object since this would result in inappropriately severe braking processes. This will be discussed

later in more detail (in connection with the explanations regarding Claim 6).

[0009] A speed control system having a distance sensor system according to the present invention thus includes no switchover to be actuated or confirmed by the driver between the so-called stop-and-go range and a range of higher driving speeds, but rather it is quasi a continuous system extending from the standstill of the vehicle to a possibly reduced maximum speed of the vehicle and contains no obvious range switchover. For this purpose there is a provision for the desired speed to be specifiable, as in the known related art, in a range between e.g. approx. 30 km/h and the (possibly reduced) maximum speed of the vehicle.

[0010] While in the known related art, an activation of the service brake on the part of the driver (that is, normally a depression of the brake pedal) is always an absolute switch-off criterion for the speed control system, now a deviation is to be made from this existing principle when the motor vehicle is at a standstill but is otherwise ready for operation.

[0011] Thus a system switch-off when the vehicle is at a standstill is now for safety reasons to be possible only by a complex operating action or operation on the part of the driver (Claim 2). For a simple operating action could also be triggered inadvertently and thus provoke a rear-end collision or the like, in particular if the host vehicle is held behind a stationary vehicle by the speed control system (having a distance sensor system) in stop-and-go operation. For then there is the danger that the driver inadvertently touches the brake pedal or a manual operating element of the system (e.g. an off-switch), whereupon the system would be switched off and whereupon at

least in the case of a downhill slope of the roadway the motor vehicle could start moving on its own. In this sense, an inadvertent actuation of the accelerator pedal (generally of a desired load sensor) would be even more critical if this would result in a system switch-off. For this reason, a system switch-off should only be able to occur in a very conscious manner.

[0012] A possible condition for a switch-off of the system on the part of the driver at a standstill and thus a complex operation in the sense of Claim 2 is for example the actuation of the service brake in combination with a simultaneous actuation of an ON-OFF switch for the speed control system, this preferably being a manual operating element (pushbutton or the like). A system switch-off from standstill may also be performed, however, if the accelerator pedal (or generally a desired load sensor to be actuated by the driver) is actuated until a specific minimum speed (e.g. 10 km/h) is reached and/or if the accelerator pedal or the like was or is actuated at least over a specific time span (e.g. for a few seconds). Thus a switch-off of the speed control system by accidentally touching the accelerator pedal may be reliably avoided.

[0013] A deviation from the usual absolute switch-off criterion for the speed control system in the form of a driver-actuation of the service brake is also made if - as provided in Claim 4 - from the standstill of the vehicle, while the service brake is actuated by the driver, the driver is able to activate the speed control system. This activation may preferably (again) occur via a manual operating element. After the system activation has occurred, the system keeps the service brake tensioned such that the driver no longer has to keep depressing the brake pedal or the like, namely, until the driver by a

drive-off command specifies a system-controlled driving operation.

[0014] In other words, in contrast to the customary existing systems, a speed control system having a distance sensor system according to the present invention is or should be activatable even when stationary, i.e. when a motor vehicle is at a standstill, but is nevertheless ready for operation. An essential criterion for the operational readiness is, for example, that the vehicle drive unit is switched on, i.e. active. For starting up the speed control system (having a distance sensor system), the driver must then first hold the motor vehicle at a standstill by actuating the vehicle service brake. Following the activation of the system on the part of the driver (for example by suitable actuation of an ON-OFF switch), the motor vehicle is further kept at a standstill by a corresponding activation of a brake actuator or the like without cooperation by the driver, in fact, in any event, i.e. regardless of whether the speed control system has detected a target object or not, i.e. even when there exists no target object at all.

[0015] In the latter case, the driver of the motor vehicle may be told via a suitable display and possibly by an additional acoustic signal that via a specific operating action he may prompt the speed control system to drive off automatically (a so-called "go request"). If, on the other hand, a target object is present or if (for example) it is detected that an initially stationary object moves away (slowly) such that this target object is detected and recognized, then with this target object moving away a so-called "go request" may also be triggered, i.e. the driver is prompted to issue a drive-off command (Claim 5).

After the driver has executed a corresponding operating action, i.e. after the drive-off command has been issued (for example in the form of confirming the "go request" signal), the speed control system is then able to release the service brake and accelerate the motor vehicle to the desired speed or allow it to follow the registered target object in a distance-controlled manner. For this purpose, the driver's so-called drive-off command may be the operation of a so-called resume button (or generally a manual operating element) or the desired load sensor, i.e. the accelerator pedal or the like.

[0016] In order to distinguish between an unintended operation of the mentioned resume button or the accelerator pedal and the issuing of a so-called drive-off command described in the preceding paragraph, it is possible to couple the corresponding operation(s) to be performed by the driver additionally with a minimum execution duration, i.e. the driver must for example press the resume button at least for a specified time period of a few seconds for the vehicle then actually to drive off automatically. The same applies to the actuation of the accelerator pedal or the like. Incidentally, in (such) a system activation in the speed range between vehicle standstill and a limit speed above which the speed control system operates analogously to systems currently in mass production, i.e. in a system activation in the so-called stop-and-go operation, the desired speed may be set automatically to the mentioned limit speed (for example 30 km/h) or to the maximum speed legally allowed within city limits.

[0017] Claim 6 indicates another logic circuit, by which the safety of a speed control system having a distance sensor system may be increased further in stop-and-go operation with respect

to the known related art. Accordingly, in a driving speed range between vehicle standstill and the possibly slightly reduced limit value for higher driving speeds, above which there is fundamentally no reaction to a priori stationary target objects, an automatic braking process at an essentially constant deceleration is initiated when detecting a stationary target object situated in the prospective driving lane. At the same time, with the exception of this mentioned braking process, the speed control system is switched off and the driver of the vehicle is emphatically alerted to this special situation.

[0018] As was mentioned already at the outset, when stationary target objects are taken into account, there is the danger that due to an erroneous detection or due to the selection of a non-relevant target object (e.g. a vehicle parked at the shoulder of the road, guardrails, etc.) a vehicle reaction is caused that is implausible both for the driver of the motor vehicle and for the following traffic, e.g. in the form of an unexpectedly severe deceleration of the vehicle motion. For this reason, the system should treat stationary target objects differently than moving target objects, although on the other hand it would not be advisable to negate the presence of stationary objects completely in stop-and-go operation, i.e. not to take stationary objects into account at all.

[0019] Here it is provided to accept no stationary target objects in the range of higher driving speeds as hitherto customary, and, in the so-called stop-and-go operation, i.e. at driving speeds, which are at least slightly below e.g. 30 km/h, to produce a certain system reaction if the probability is high that the ascertained object, which is stationary from the

beginning (i.e. a priori), is located in the driving lane of the motor vehicle having the speed control system. According to the present invention, this reaction is to be that the motor vehicle for safety reasons is braked at a relatively low (and essentially constant) deceleration and that (essentially at the same time) the speed control system is switched off. Of course, in the process, the initiated deceleration or the started braking operation is continued. For this purpose it is essential that the driver of the motor vehicle is made aware of this situation, i.e. that the driver is informed via a signal or the like that the system has not only detected a stationary object (blocking the way), but that the system has switched itself off automatically such that the further driving behavior is from now on specified solely by the driver.

[0020] As is indicated in Claim 7, only a stationary target object situated in the prospective driving lane, which the motor vehicle has approached up to a certain limit distance, may be taken into account in the manner just described, it being possible for the magnitude of this limit distance to be variable and to depend on the current driving speed.

[0021] Only for reasons of completeness should it be mentioned that a sensible, because relatively non-critical, value for the essentially constant deceleration mentioned in Claim 6 is in the order of magnitude of $1.5 m/s^2$. Furthermore, it should be pointed out that for system-controlled braking operations without an associated system switch-off it may be practical if in the stop-and-go operation higher acceleration and deceleration limits are permitted than in (currently already mass-produced) **[sic]** driving operation at higher driving speeds (in which fundamentally no stationary target objects are taken

into account) since in the stop-and-go operation and thus in a relatively low speed range there must possibly occur a very quick reaction to a preceding vehicle or target object. For this purpose it is quite possible to define a transitional range, in which the respective deceleration limit values etc. are continually adapted as a function of the current driving speed.

[0022] With the exception of the described "special reaction" to an ascertained stationary object in the host vehicle's own driving lane (that is, the braking operation at an essentially constant deceleration and system switch-off), only traveling or driving-off or stopping objects are thus accepted as relevant target objects. If a traveling target object brakes all the way to a standstill, however, while the motor vehicle equipped with the speed control system according to the present invention follows it, then this object is likewise accepted as a target object. Fundamentally, the indicated operating actions and operating states become simpler and transparent for the driver. At the same time, the danger of erroneous detections and of system reactions that are not adapted to the traffic situation is minimized, it additionally being pointed out that it is quite possible for a multitude of details to be developed in deviation from or by way of supplementation to the above explanations without departing from the content of the claims.